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(71) Applicant *(for all designated States except US):* RESERVE BANK OF AUSTRALIA trading as NOTE PRINTING AUSTRALIA [AU/AU]; Hume Highway, Craigieburn, VIC 3064 (AU).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* JACKSON, Wayne, Kevin [AU/AU]; 69 Darebin Boulevard, Reservoir, VIC 3073 (AU).

(74) Agent: CARTER SMITH & BEADLE; Qantas House, 2 Railway Parade, Camberwell, VIC 3124 (AU).

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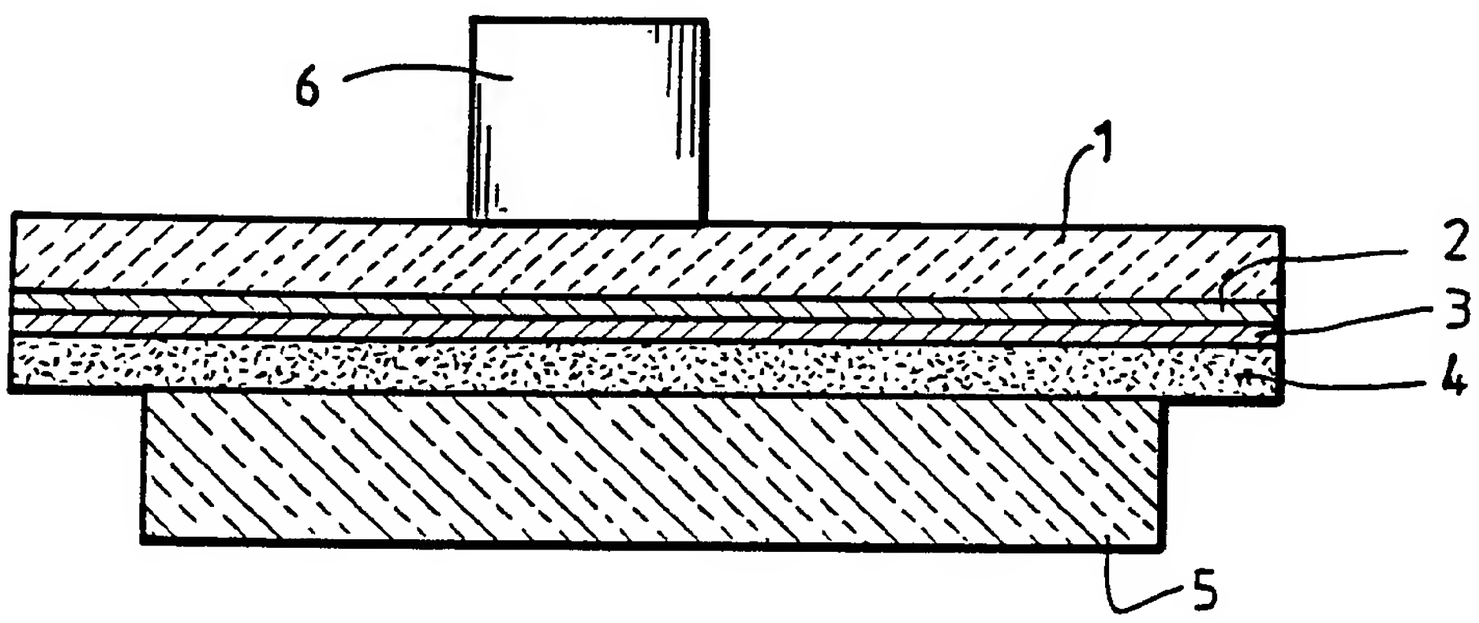

(57) Abstract

In one aspect of the invention there is provided a medium for applying an optically variable device to a security document (5) comprising a carrier web (1) and a release coating (2), or a carrier web (60) having a low surface energy release surface on one side thereof, a thin metallic film (3) suitable for carrying an optically variable device and an adhesive layer (4) which is able to be embossed or otherwise mechanically modified under heat and pressure applied by a die (6) to the metallic film (3), the release coating (2) or surface being such that the metallic film (3) is exposed when an element of the film is secured to a security document (5). There is also provided a method of and apparatus for applying an optically variable device to a security document which uses the medium and in which the exposed metallic foil (3) is embossed to form the optically variable device after the metallic film (3) has been transferred to the security document.

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APPLYING DIFFRACTION GRATINGS TO SECURITY DOCUMENTS

Field of the Invention

This invention relates to the application of diffraction gratings to security documents or devices, such as banknotes, share certificate, bonds, credit cards and the like.

Background of the Invention

The practice of applying diffraction gratings and the like to security devices such as credit cards has become widely adopted. The present applicant has pioneered a process of printing banknotes on a plastics film to provide increased banknote note security and life, and the banknote notes had a thin metallic foil or foil bearing an optically variable device adhesively secured thereto so as to be visible from either side through a transparent portion of the banknote note.

The current practice adopted in preparing an optically variable device for transfer to a banknote note or credit card usually involves the following steps:

A polyester carrier film is coated with a thin release coating followed by a thicker embossing layer formed from a suitable thermo plastic, such as polymethylmethacrylate, which is then embossed to form the required diffraction grating or other like device under heat and pressure to thereby physically modify the embossing layer. The embossing layer is then metallised to form a thin aluminium coating, onto which a hot melted adhesive coating is applied. The foil is then ready to be affixed to the banknote note by a platen press which transfers the foil to the required position over the banknote note by the detection of suitable register marks to locate the foil directly under a hot stamping die carried by the platen which causes the adhesive to be bonded to the banknote note to secure the foil element carrying the optically variable device in the required position.

Since the foil and carrier manufacturing method is complicated by the need to emboss the embossing layer prior to metallising it, the cost of the foil is correspondingly

increased. Large embossing pressures are produced due to the large width of the embossing cylinders used in the described process. The above process also requires the hot stamping die and the substrate to be kept extremely clean and this further increases the production cost due to the extensive down times required.

In addition, since the foil is formed with the optically variable device prior to its application to the banknote note or security device, the maintenance of the required registration between the foil element carrying the optically variable device and the required banknote note or security device location is extremely important.

Furthermore, the above described transfer process tends to involve shear forces being applied between the foil and the carrier film, which sometimes results in pin holing during the transfer process thereby spoiling the foil carrying the optically variable device. This in turn requires a slowing of the production rate to a speed of the order of 1,750 sheets per hour, and even at this speed the spoilage rate is still high. Of course, the capacity of a banknote note printing press is of the order of 8,000 sheets per hour so the foil applying process significantly delays the overall production process.

Still further, since the security diffraction gratings remain with the carrier until they are applied to the document or device, the risk of pilfering is increased.

Summary of Invention and Object

It is an object of the present invention to provide an improved medium for applying an optically variable device to a security document or device which reduces production costs, and to provide a method and system for applying diffraction gratings to documents or security devices by means of which at least several of the above described disadvantages are at least ameliorated.

In a first aspect, the invention provides a medium for applying an optically variable device to a security document or device, comprising a carrier web, release means in or on said web, a thin metallic film or foil applied to

said release means and suitable for carrying an optically variable device, an adhesive layer which is able to be embossed or otherwise mechanically modified under heat and pressure applied to said metallic film or foil, said release means being such that the metallic film or foil is exposed when an element of said film is adhesively secured by means of said adhesive layer to the document or device.

Since the metallic film or foil is exposed after transfer to the document or device, it may be modified under heat and pressure after transfer to form an optically variable device thereby significantly ameliorating several of the disadvantages outlined above. A protective coating may then be applied to the exposed optically variable device.

The carrier web may take any suitable form, including suitable polymers, but is most conveniently a Mylar (Registered Trade Mark) web, as is commonly used in the prior art outlined above, or polypropylene.

The release means may comprise a thin release coating which may comprise any suitable material which maintains the metallic film or foil on the web but facilitates release when the film is peeled from the web during the transfer process. In one convenient form a suitable acrylic material known in the art is used and is of the order of 0.01 to 0.1 microns thick, and most preferably not greater than 0.1 microns thick.

Alternatively, the carrier web may be made from polypropylene, for example about 30 microns thick, and having reduced surface energy on one side, for example about 32 dynes. In this case, the low surface energy operates in a manner similar to the release coat of the previously defined embodiment. Thus, in this embodiment, the low surface energy side of the web is metallised and an adhesive layer is then applied to the metallised film.

The metallic foil or film is formed on the release coating in any known manner, such as by aluminium vapour deposition. The foil is of the order of 250 to 300 Å thick and is most preferably about 275 Å thick.

The adhesive layer is formed from an embossable thermoplastic adhesive material, such as a suitable acrylic, and in one embodiment the known acrylic thermoplastic adhesive polymethylmethacrylate is used. The characteristics of the thermoplastic adhesive are selected to ensure proper adhesion of the foil to the document or device at the most convenient temperature to be applied at the required transfer speed whilst also facilitating embossing deformation of the metallic film under heat and pressure at the same transfer speed. The adhesive should of course be relatively transparent to enable viewing of the optically variable device from either side in the case of a transparent banknote.

In another aspect, the invention provides a method of applying an optically variable device to a security document or device comprising the steps of transferring an adhesive coated thin metallic film from a carrier web to a document or device, applying heat and pressure to adhesively secure an element of said metallic film to the document or device, and embossing or otherwise mechanically modifying said metallic film to form an optically variable device or similar device in said metallic film.

The mechanical modification of the metallic film is preferably achieved by applying heat and pressure to the film and the underlying adhesive layer via a heated die. To ensure that the security document or device is not deformed excessively during this procedure, the document or device is preferably supported by a resilient surface having a high degree of planarity and hardness while being very resilient so as to recover after the embossing or impression has been completed. The surface preferably has a Shore hardness of the order of 80D such that there is less than 0.15 micron and preferably not greater than about 0.1 micron deflection of the security document or device when an embossing pressure of the order of 800 kPa is applied by means of the embossing die.

After the metallic film has been embossed or otherwise modified to form the optically variable device, a

protective coating may then be applied to the optically variable device to prevent damage to the device.

The protective coating may be applied to the optically variable device by transferring the coating from a carrier film. Preferably the coating is formed of a thermoplastic material that is adapted to adhere to the optically variable device by the application of heat and pressure.

An alternative method of applying a protective coating is to transfer a liquid coating to the exposed surface of the optically variable device using a letterpress printing process. The coating may then be cured by exposure to ultraviolet radiation.

The security document or device is preferably supported on a transfer surface during the step of transferring the adhesively coated metallic foil from the carrier web to the security document or device. The transfer surface is preferably resilient and may also constitute the surface on which the security document or device is supported during the embossing process. The security document or device is preferably maintained in contact with the transfer surface for a period of time sufficient to allow the adhesive to cool and solidify, either under ambient conditions or by cooling the adhesive and/or metallic film. The carrier is then peeled from the transfer surface at a relatively low angle to reduce the amount of shear which is applied to the metallic film whereby the adhered element of metallic film is broken from the parent film while avoiding the problems outlined above.

The angle at which the carrier web is removed from the transfer surface is preferably substantially less than 90°, more preferably less than 45° and most preferably in the range 10 to 30°, for example about 15°.

The adhered element of metallic film is then embossed or otherwise modified under heat and pressure, preferably using the same supporting surface, without disturbing the adhesive securement of the metallic film element and without the need for the accurate registration required by the prior art, other than easily achieved mechanical

synchronism between the respective transfer dies and the respective embossing dies.

In another aspect, the invention provides a system for applying an optically variable device to a security document or device, comprising a transfer surface having low deflection characteristics for supporting the security document or device, means for passing a thermoplastic adhesive coated metallic film on a carrier web in overlying relation to said document or device on said transfer surface, transfer die means for applying heat and pressure to a discrete area of said metallic film to transfer and adhere same to said document or device, embossing or other modifying means for embossing or otherwise mechanically modifying said discrete area of film adhered to said document or device to produce an optically variable device therein, and means for taking up said carrier web following operation of said transfer die means in a manner which peels the carrier from the metallic film to reduce the shear forces applied to the metallic film during the transfer process.

The system may also provide a means to apply a protective coating to the formed optically variable device.

The system preferably includes means for holding the metallic film in contact with the transfer surface for a period sufficient to allow the adhesive to cool and solidify before the carrier web is peeled from the adhesively secured discrete area of film. This may be achieved by means of a roller which guides the metallic foil and carrier web to keep it in contact with the transfer surface for the required period. The roller is preferably in the form of an air bar to reduce frictional forces applied to the carrier web. The transfer surface is preferably in the form of a roller surface to which a blanket of rubber or other resilient material is applied. If desired, the blanket may be covered by a thin sheet of metal, such as steel, aluminium or titanium to keep the transfer surface true. The characteristics of the rubber blanket should be such that there is less than about 0.15

microns of deflection when the metallic foil is embossed.

The transfer die means preferably comprises a plurality of transfer dies carried by a cylinder driven at the same surface speed as the transfer surface and mounted to apply the required transfer pressure to the heated transfer die. Similarly, the embossing or modifying means preferably comprises a plurality of dies carried by a cylinder driven at the same surface speed as the transfer surface and mounted to apply the required pressure to the discrete areas of metallic film via the embossing or modifying dies.

In one preferred form of the invention, each embossing means is in the form of a diffraction grating formed in a generally cap-shaped member which is secured to a discrete carrier or "pig's foot" detachably secured to the cylinder. The cap-shaped member on which the diffraction grating is formed is easily removed for replacement purposes, as will be described in further detail below.

By using the above system, very high application speeds may be maintained on a regular basis thereby resulting in significant improvements in productivity. As mentioned above, the production rate is increased from about 1750 sheets per hour to about 8000 sheets per hour, which corresponds to an approximate surface speed of the order of 95 metres per minute.

Brief Description of the Drawings

In order that the invention may be more readily understood, one presently preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a schematic sectional elevation of one preferred embodiment of a medium for transferring a foil capable of being formed into a diffraction grating;

Figures 2a to 2c are schematic diagrams showing the foil transfer and embossing processes;

Figure 3 is a schematic diagram of one preferred embodiment of a system for transferring and embossing the foil;

Figure 4 is a more detailed schematic side elevation of a prototype system embodying the transfer principals shown in Figure 3;

Figure 5 is a detailed fragmentary elevation of the foil feeding and laminating mechanism which ensures continuous supply of foil;

Figure 6 is a detailed elevation of the transfer and embossing mechanism shown in Figures 3 and 4;

Figures 7 and 8 are fragmentary details of the transfer mechanism showing the manner in which it is attached to its cylinder;

Figures 9 and 10 are similar details of the embossing mechanism showing its means of attachment to its cylinder;

Figure 11 is a schematic sectional elevation showing the manner in which a metallic cap having a release surface is detachably secured to the embossing die; and

Figure 12 is a schematic sectional elevation of another preferred embodiment of a medium for transferring a foil capable of being formed into a diffraction grating.

Description of preferred embodiment

Referring firstly to Figures 1 and 2 of the drawings, the preferred transfer member embodying the invention comprises a carrier web 1 of Mylar of the type commonly used in the art, and in the present embodiment, this web is about 23 microns thick. The web 1 has a release coat 2, approximately 0.1 micron thick applied to one surface. The release coat may comprise any suitable release material known in the art, and is most suitably an acrylic material commonly used for this purpose. The release coat 2 is coated with an aluminium film or foil 3 about 275 Å thick, applied in any known manner such as by vapour deposition. The surface of the aluminium foil is coated with a suitable thermoplastic adhesive 4 about 1.5 microns thick. In the present embodiment, the preferred adhesive is an acrylic such as polymethylmethacrylate, which has the advantage of being transparent and of having a glass transition point at around 105°C whereby it may function as an adhesive at the transfer speed referred to above.

One suitable adhesive formulation and method of preparation is detailed below.

Formulation

n-Butyl-methacrylate	45%
Ethylene-vinyl acetate	25%
Dimerized Rosin	18%
SiO2	5%
Vinyl chloride-acetate resin	7%
	100%

Preparation

All components are premixed as 20% solutions, as described below, and kept separately until use, except for the Ethylene-vinyl acetate, which is mixed on the day of use.

The adhesive is prepared by combining all components together with mixing and heating at about 40°C.

The n-Butyl-methacrylate, Ethylene-vinyl acetate and dimerized rosin are all prepared by dissolving in toluene with mixing and heating at about 40°C.

The vinyl chloride-acetate resin is dissolved in methyl ethyl ketone (MEK) solvent at room temperature (about 25°C).

The SiO2 is prepared by mixing into a paste in toluene.

Running Conditions

The temperature of the adhesive should be maintained between about 35°C and about 40°C (separation of the components will occur if the temperature drops below about 25°C. The viscosity of the adhesive should be between about 20 to 22 seconds Zahn cup 2.

The film weight applied, for example by gravure press, should be between 0.9 and 1.2 grams per square meter.

As shown schematically in Figure 1 of the drawings, the foil 3 and adhesive 4 are transferred to a substrate 5, such as a paper or plastic banknote or security document using a transfer die 6. The transfer process is shown schematically in Figure 2b while the embossing of the transferred elements of aluminium foil 3a and adhesive 4a

is shown schematically in Figure 2c. Heat and pressure are applied to the elements 3a and 4a via a heated embossing die 7 which mechanically modifies the metal foil element 3a and the underlying thermoplastic adhesive 4a to form an optically variable device 8, such as a diffraction grating. Thus, the adhesive layer 4 is selected not only for its rapid thermoplastic adhesive properties, but also for its ability to thermoplastically deform under the heat and pressure applied by the die 7.

A transparent protective coating is then transferred to the metallized and embossed device by a coating die using two alternative methods. In the first method the protective coating is applied to the exposed device by transferring the coating from a carrier film. The coating would preferably be a thermoplastic material which adhered to the exposed surface of the device by the application of heat and pressure.

In the second method a liquid coating is transferred to the exposed surface of the device using a letterpress printing process. The coating is then cured by exposure to ultra violet radiation.

While the coating application method may be alternated depending on the method required, it is essential that the resultant protective coating is transparent.

Referring now to Figures 3 and 4 of the drawings, one presently preferred system for applying diffraction gratings to banknotes will now be described. Figure 3 shows the concept of the system embodying the invention schematically while Figure 4 shows a prototype system in broad detail.

The preferred system comprises a substrate supporting cylinder 10, having a rubber blanket 11 secured to its outer surface to provide a resilient defect free surface which provides less than 0.15 micron deflection in the transfer and embossing processes to protect the substrate 5 against any noticeable debossing. The blanket preferably comprises a polyurethane (modulus of about 40 MPa) sub-blanket layer of between 0.2 to 2.5 mm thick. To provide

the necessary accurate planarity of the surface of the cylinder 10, the blanket has a titanium sheet 0.2 to 1.5 mm thick secured to the outer surface of the sub-blanket layer. The substrate 5 is held in contact with the surface of the cylinder 10 by cylinders 12 and 13, as shown in Figures 3 and 4.

The composite film described in greater detail above, and which will be generally identified by the reference numeral 1, is fed from a reel 14 over air bars 15 and 16 into a vacuum box 17 in which a loop 18 of the composite film 1 is drawn to control the feeding rate and inertia of the composite film 1. An air flow rate of about 0.46 m^3/min is sufficient to suitably control the film 1.

The air bars 15 and 16 comprise porous tubes of aluminium through which air under pressure is fed to create low friction supports for the composite film 1.

The vacuum box comprises an elongate chamber 19 having a suction opening 20 through which air is withdrawn from the chamber 19 in a controlled manner to vary the size of the loop 18 to control the feed rate of the composite film 1 over the surface of the cylinder 10 during the transfer and embossing operations to be described further below.

Further air bars 21, 22 support the composite film 1 as it emerges from the vacuum box 17 and spaced air bars 23 and 24 are positioned to hold the composite film in contact with the surface of the cylinder 10 over a predetermined portion of the periphery of the cylinder 10 to facilitate setting of the adhesive transferred to the substrate 5 during the transfer process.

The composite film passes over a further air bar 25 and into a take up vacuum box 26 via air bars 27, 28 to create variable loops 29 which control the feeding rate and inertia of the film 1 in conjunction with the vacuum box 17. The film passes over air bar 30 to a take up reel 32. Alternatively, the remaining parts of the composite film 1 are suitably trashed by some form of cutting mechanism immediately after the air bar 30 for greater ease of disposal.

The transfer process referred to above is effected by a cylinder 33 carrying a multiplicity of heated transfer dies spaced around the periphery of the cylinder 33, as shown in greater detail in Figure 5 of the drawings. The cylinder 33 is held in contact with the surface of the cylinder 10 in a known manner so as to apply the required transfer force to the film to transfer elements of metallic foil 3 and adhesive 4 so as to adhesively secure the foil elements to the surface of the substrate 5. The spacing between the transfer dies is of course selected to correspond to the spacing between the banknotes printed on the substrate 5. The air bars 23 and 24 are positioned to ensure that the transferred foil and adhesive 3, 4 is undisturbed contact with the surface of the cylinder 10 for a sufficient time to ensure that appropriate hardening of the adhesive 4 occurs before the remainder of the composite film 1 is peeled from the transferred element 3a, 4a. As clearly shown in Figure 3 of the drawings, the composite film 1 is peeled from the transferred elements 3a, 4a at a relatively low acute angle and which is substantially less than 90°, and most preferably around 12°, to reduce the shear force effects applied to the foil as it is peeled from the parent foil during the transfer process.

The embossing process is achieved by cylinder 34, which carries a correspondingly spaced multiplicity of embossing dies, shown in greater detail in Figure 6. Again the cylinder 34 is held in contact with the surface of the cylinder 10 so as to apply the requisite embossing force and heat to the foil element 3a and the underlying adhesive 4 to emboss the surface of the foil element 3a with a diffraction grating formed on the surface of the embossing dies.

As shown in greater detail in Figure 6 of the drawings, the transfer cylinder 33 has a multiplicity of transfer dies 6 attached to its surface at spaced intervals corresponding to the intervals at which the banknotes on the substrate 5 are presented at the surface of the cylinder 10. Each transfer die 6 comprises a shaped die

member 40, in the present embodiment generally oval in shape, which is secured to a holder 41 which is in turn secured to the cylinder 33 in the general manner shown in Figures 6 and 7 and 8 of the drawings. Each die member 40 is in the form of a so-called "pig's foot" which is detachably secured to the support 41 to enable it to be easily replaced when worn. As mentioned above, the transfer cylinder 33 is mounted for co-rotation with the cylinder 10 so that each die member 40 applies a transfer force to the combined film 1 when it is in contact with the surface of the cylinder 10. Each die member 40 is heated by means not shown in the drawings so that the interface temperature is above about 110°C and less than 150°C, at which temperature the adhesive 4 becomes sufficiently tacky to cause adhesive securement of the foil element 3a to the surface of the substrate 5. In this regard, the carrier web 1 must allow the adhesive 4 to melt and then cool down at a very high rate, the surface speed being of the order of 95 metres per minute, without causing a break in the web 1. During the short time that the film element 3a is under the transfer die, the adhesive is sufficiently melted to cause adhesive securement, but since the combined film 1 is kept in contact with the surface of the cylinder 10, the adhesive is allowed to cool and increase its bond to the substrate 5 sufficiently to allow the carrier web 1 to be stripped away from the foil element 3a with the peeling action of the web 1 with respect to the foil element 3a ensuring a good clean break between the element 3a and adhesive element 4a and the remainder of the film 3 and adhesive layer 4. As mentioned above, the characteristics and thickness of the release coating 2 should be selected to ensure that this process is facilitated.

The die member must therefore be at a temperature which transfers sufficient heat in the contact time (less than 0.8 m/s) to the transfer foil to allow the adhesive to melt. However it has been found that die member face temperatures at about 200°C provides a sufficient interface temperature but die face temperatures in excess of 230°C

cause distortion of the transfer foil resulting in a poor product.

To reduce the contact time required to melt the adhesive and avoid increasing the temperature of the die member 40, the transfer foil element may be preheated prior to contact with banknote note substrate. The preheating allows the interface between the note substrate and the transfer foil to quickly gain the required 110°C without increasing the die member temperature. The interface temperature does not exceed the 150°C limit as a consequence and the difference in dwell time is substantial which is reflected in the improved quality of the transfer produced.

The pigs feet which employ thin metal caps to contact the transfer foil are inductively heated. The thin metal caps have low thermal inertia which allows the initial heat to penetrate the carrier quickly but the limited thermal capacity of the metal caps causes the rate of heating to drop quickly thus containing the maximum temperature achieved.

To provide adequate contact times during the transfer process, impression levels must be of the order of 0.25 mm. The blanket must tolerate this loading and demonstrate an acceptable life.

While a blanket made totally from polyurethane will undergo substantial deformation without set, it has been found that transfer quality ultimately degrades by the high level of strain related migration from under the pig's foot.

The applicants have found that a cover/sub-blanket combination will provide adequate life under the levels of impression required. The preferred combination is a titanium blanket sheath or cover with a low durometer polyurethane sub-blanket.

The embossing cylinder 34 is of similar construction to the cylinder 33 and carries a series of embossing die members 42 mounted on supports 43 secured in the manner shown in Figures 9 and 10 to the cylinder 34. As shown in

Figure 11 of the drawings, each embossing die 42 comprises a "pig's foot" 44 over which a metallic cap 45 having an outwardly directed relief surface 46 in the form of a diffraction grating or the like is held to the "pig's foot" 44 by a retaining ring 47. This method of providing the diffraction grating relief surface 36 enables the caps 45 to be regularly changed in a simple and convenient manner to maintain the quality of the impression formed in the foil element 3a and the underlying adhesive element 4a to provide a good quality optically variable device. As in the case of the transfer cylinder 33, the embossing cylinder 34 is loaded against the surface of the cylinder 10 to apply the requisite embossing force to the elements 3a and 4a, and the embossing dies means 42 are heated by means not shown to a temperature of about 75°C to ensure that the relief 46 embosses the surface of the foil element 3a and the underlying adhesive element 4a to provide the optically variable device.

To provide the necessary temperature retention the embossing shim 45 is preferably a steel cap, at least 1 mm thick with a 0.1 to 0.12 mm thick electro deposited nickel layer. The shim is fitted to the ceramic pigs' feet and may be direct induction heated.

Since the transfer and embossing processes are performed against the same supporting surface, the necessary register between the respective cylinders 33 and 34 is achieved in a relatively simple mechanical manner and no sophisticated register detecting devices are required.

As shown in Figure 4 of the drawings, a coating cylinder or drum 50 for applying a transparent protective coating to the exposed optically variable devices may be provided. The cylinder or drum may, for instance, be driven at the same surface speed as the transfer surface and have a plurality of coating heads for transferring the coating to the exposed optically variable device. The coating may be applied either from a carrier film or by a letterpress printing process which applies a liquid coating with a source of ultraviolet radiation being provided for

curing the liquid coating.

As shown in Figure 4 of the drawings, after application of the transparent coating, the substrate 5 is transferred from the cylinder 10 to collection positions via the cylinder 13 and other cylinder arrangements illustrated in this Figure. If desired, a number applying cylinder (not shown) may be provided to apply the necessary distinguishing numbers to the individual banknotes on the substrate 5. In the detail shown in Figure 5, there is an additional reel 51 of composite film 1 mounted beneath the reel 14 and a known laminating mechanism 52 is provided to laminate a fresh composite film 1 from the reel 51 to the existing film 1, using heat and adhesive tape, when the reel 14 is exhausted. In this way, the supply of film 1 to the transfer and embossing processes is substantially continuous.

It will be appreciated from the above that the improved combined film 1 and the system for transferring and embossing the film and adhesive elements 3a and 4a provide considerable production and other advantages when compared with the prior art systems outlined above. The low deflection nature of the transfer surface 11 of the cylinder 10 ensures that the substrate 5 will have little if any noticeable debossing, and since the elements 3a and 4a are securely adhered to the substrate 5 before the remaining carrier web 1, aluminium film 3 and adhesive layer 4 are peeled away from the elements 3a and 4a with significantly reduced shear forces, the transfer speed may be significantly increased without increasing the spoilage or defect rate. Furthermore, by accurately controlling the operation of the vacuum boxes 17 and 26 by monitoring the position and speed of the film 1 in the transfer and embossing zones, the shear forces involved in the transfer processes are further reduced or controlled and the use of the foil 3 is minimized to thereby contain the cost of providing the diffraction gratings. Since both transfer and embossing is achieved in the one operation against a common transfer surface, the necessary control of the

position of the substrate 5 with respect to the transfer dies 6 is more easily achieved to ensure that the optically variable device is properly registered on the document printed on the substrate 5. In the particularly preferred embodiment, the use of discrete cap members 45 carrying the necessary diffraction relief surface 46 enables rapid changeover when the caps are damaged or worn, and this is far more cost effective than replacing an entire embossing plate as was necessary when any defect was detected in the prior art method.

In another embodiment of the medium shown in Figure 12 of the drawings, the carrier web 60 is polypropylene about 30 microns thick treated in a known manner so that the surface energy of the lowermost side shown in the drawing has a reduced surface energy of the order of 32 dynes. When polypropylene film is produced, it is usual for both surfaces of the film to be ionized in a known manner, and the reduced surface energy referred to above can be achieved by not ionizing the lowermost surface.

The lowermost surface of the carrier web 60 is metallised, as in the first embodiment, with an aluminium film 62 about 275 Å thick, and a coating 63 of embossable adhesive about 1.5 microns thick is applied to the metallised film 62. The embossable adhesive may be of the same form as described in the embodiment of Figures 1 and 2 of the drawings.

One advantages of this embodiment is that no release coating is required to be applied to the carrier web, as in the previous embodiment. However, the previous embodiment is presently preferred since the release coating functions properly to release the metallised layer and adhesive layer from the carrier.

Since modifications within the spirit and scope of the invention may be readily effected by persons skilled in the art, it is to be understood that the invention is not limited to the particular embodiment described, by way of example, hereinabove.

CLAIMS:

1. A medium for applying an optically variable device to a security document or device, comprising a carrier web, release means in or on said web, a thin metallic film or foil applied to said release means and suitable for carrying an optically variable device, an adhesive layer which is able to be embossed or otherwise mechanically modified under heat and pressure applied to said metallic film or foil, said release means being such that the metallic film or foil is exposed when an element of said film is adhesively secured by means of said adhesive layer to a security document or device.

2. A medium according to claim 1 wherein the exposed metallic film or foil is able to be embossed or otherwise mechanically modified under heat and pressure to form an optically variable device after it has been adhesively secured to the security document or device.

3. A medium according to claim 2 wherein the exposed metallic film or foil is adapted to receive a protective coating after formation of the optically variable device.

4. A medium according to claim 1 wherein the carrier web is formed from a polymeric material, such as Mylar (Registered Trade Mark) or polypropylene.

5. A medium according to any one of claims 1 to 4 wherein the release means comprises a thin release coating applied to the web.

6. A medium according to claim 5 wherein the release coating is formed from an acrylic material of a thickness falling substantially within the range from 0.01 to 0.1 microns.

7. A medium according to any one of claims 1 to 4 wherein the release means comprises a release surface on one side of the carrier web having reduced surface energy.

8. A medium according to claim 7 wherein the carrier web comprises a polypropylene web treated so that said one side of the web has a reduced surface energy.

9. A medium according to claim 7 or claim 8 wherein the surface energy of the release surface of the carrier web is about 32 dynes.

10. A medium according to any one of claims 1 to 4 wherein the metallic film or foil is formed from aluminium.

11. A medium according to claim 10 wherein the thickness of the aluminium film or foil is from 250Å to 300Å.

12. A medium according to claim 11 wherein the thickness of the aluminium foil is about 275Å.

13. A medium according to any one of claims 1 to 4 wherein the adhesive layer is formed from an embossable thermoplastic adhesive material.

14. A medium according to claim 13 wherein the adhesive layer is polymethylmethacrylate.

15. A medium according to claim 13 wherein the adhesive layer is about 1.5 microns thick.

16. A method of applying an optically variable device to a security document or device comprising the steps of transferring an adhesive coated thin metallic film from a carrier web to the document or device, applying heat and pressure to adhesively secure an element of said metallic film to the document or device, characterised by the step of embossing or otherwise mechanically modifying said metallic film to form an optically variable device or similar device in said metallic film.

17. A method according to claim 16 wherein the step of embossing or otherwise mechanically modifying said metallic film is carried out after the metallic film has been transferred to the security document or device.

18. A method according to claim 17 wherein the metallic film is mechanically modified to form the optically variable device by applying heat and pressure to the film and the underlying adhesive layer via a heated die.

19. A method according to claim 18, further comprising the step of supporting the security document or device by a resilient surface during the step of mechanically modifying the metallic film.

20. A method according to claim 19 wherein the resilient surface has a hardness such that there is less than 0.15 micron deflection of the security document or device during the step of mechanically modifying the metallic film.

21. A method according to any one of claims 16 to 20 further comprising the step of applying a protective coating to said optically variable device.

22. A method according to claim 21 wherein the protective coating is applied to the optically variable device by transferring the coating from a carrier film.

23. A method according to claim 22 wherein the protective coating is formed of a thermoplastic material which can adhere to the optically variable device by the application of heat and pressure.

24. A method according to claim 21 wherein a liquid coating is applied to the optically variable device by means of a letterpress printing process.

25. A method according to claim 24 wherein the coating is cured on the optically variable device by exposure to ultra violet radiation.

26. A method according to any one of claims 16 to 20 wherein the security document is supported on a transfer surface during the step of transferring the adhesively coated metallic film from the carrier web to the security document or device and the metallic film is transferred to the security document or device by applying heat and pressure.

27. A method according to claim 26 wherein the security document or device is maintained in contact with the transfer surface for a period of time sufficient to allow the adhesive to cool and solidify.

28. A method according to any one of claims 16 to 20 further comprising the step of removing the carrier web from the transfer surface after the film has been adhesively secured to the security document or device by peeling the web from the transfer surface at a relatively low angle which is substantially less than 90°.

29. A method according to claim 28 wherein the carrier web is peeled from the transfer surface at an angle less than 45°.

30. A method according to claim 29 wherein the carrier web is peeled from the transfer surface at an angle less than 30°.

31. A method according to claim 29 wherein the carrier web is peeled from the transfer surface at an angle falling substantially within the range from 10° to 30°.

32. A security document or device including an optically variable device formed by the method of any one of claims 16 to 31.

33. A system for applying an optically variable device to a security document or device, comprising a transfer surface having low deflection characteristics for supporting the security document or device, means for passing a thermoplastic adhesive coated metallic film on a carrier web in overlying relation to said document or device on said transfer surface, transfer die means for applying heat and pressure to a discrete area of said metallic film to transfer and adhere said discrete area of said metallic film to said document or device, embossing or other modifying means for embossing or otherwise mechanically modifying said discrete area of metallic film adhered to said document or device to produce an optically variable device therein, and means for taking up said carrier web following operation of said transfer die means in a manner which peels the carrier from the metallic film to reduce the shear forces applied to the metallic film during the transfer process.

34. A system according to claim 33 further comprising means for holding the metallic film in contact with the transfer surface for a period sufficient to allow the adhesive to cool and solidify before the carrier web is peeled from the adhesively secured discrete area of the metallic film.

35. A system according to claim 34 wherein the holding means comprises a roller which guides the foil and carrier

web to keep it in contact with the transfer surface for the required period.

36. A system according to claim 35 wherein the roller is in the form of an air bar.

37. A system according to claim 33 wherein the transfer surface is in the form of a roller surface to which a blanket of rubber or other resilient material is applied.

38. A system according to claim 37 wherein the blanket is covered by a thin sheet of metal.

39. A system according to claim 37 wherein the blanket comprises a titanium sheet on a polyurethane sub-layer.

40. A system according to claim 33 wherein the transfer die means preferably comprises a plurality of heated transfer dies carried by a transfer cylinder driven at the same surface speed as the transfer surface and mounted to apply the required transfer pressure to the transfer dies.

41. A system according to claim 33 or claim 40 wherein the embossing or modifying means comprises a plurality of embossing dies carried by an embossing cylinder driven at the same surface speed as the transfer surface and mounted to apply the required embossing pressure to the discrete areas of the metallic film adhesively secured to the security document or device.

42. A system according to claim 40 or claim 41 wherein each transfer die and/or each embossing die comprises a die member which is detachably secured to the transfer cylinder or embossing cylinder.

43. A system according to claim 41 wherein each embossing die comprises a cap-shaped member secured to a discrete carrier member, the cap-shaped member having an outwardly directed relief surface in the form of a diffraction grating.

44. A system according to claim 43 wherein the discrete carrier member is in the form of a "pig's foot" and the cap-shaped member is secured to the carrier member by a retaining ring.

45. A system according to claim 33 further comprising coating means for applying a protective coating to the

optically variable device formed by the embossed or otherwise modified discrete area of metallic film on the security document.

46. A system according to claim 45 wherein the coating means comprises a plurality of coating heads mounted to a cylinder driven at the same surface speed as the transfer surface.

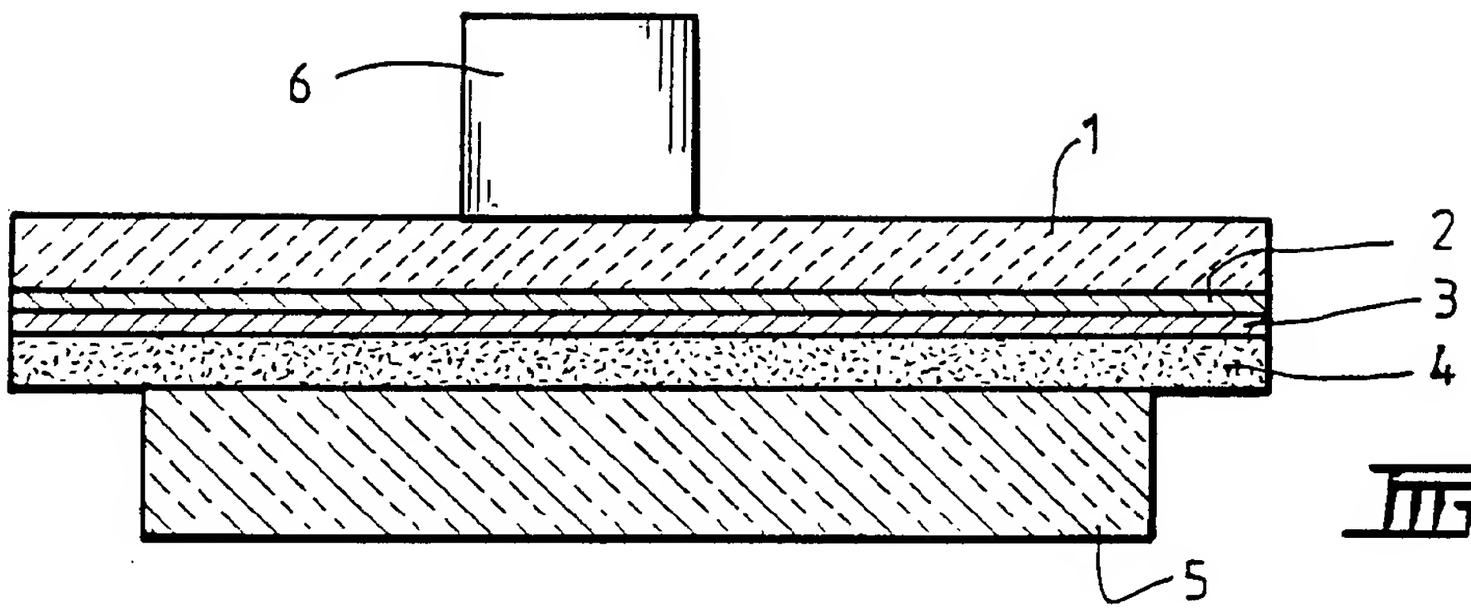

FIG. 1.

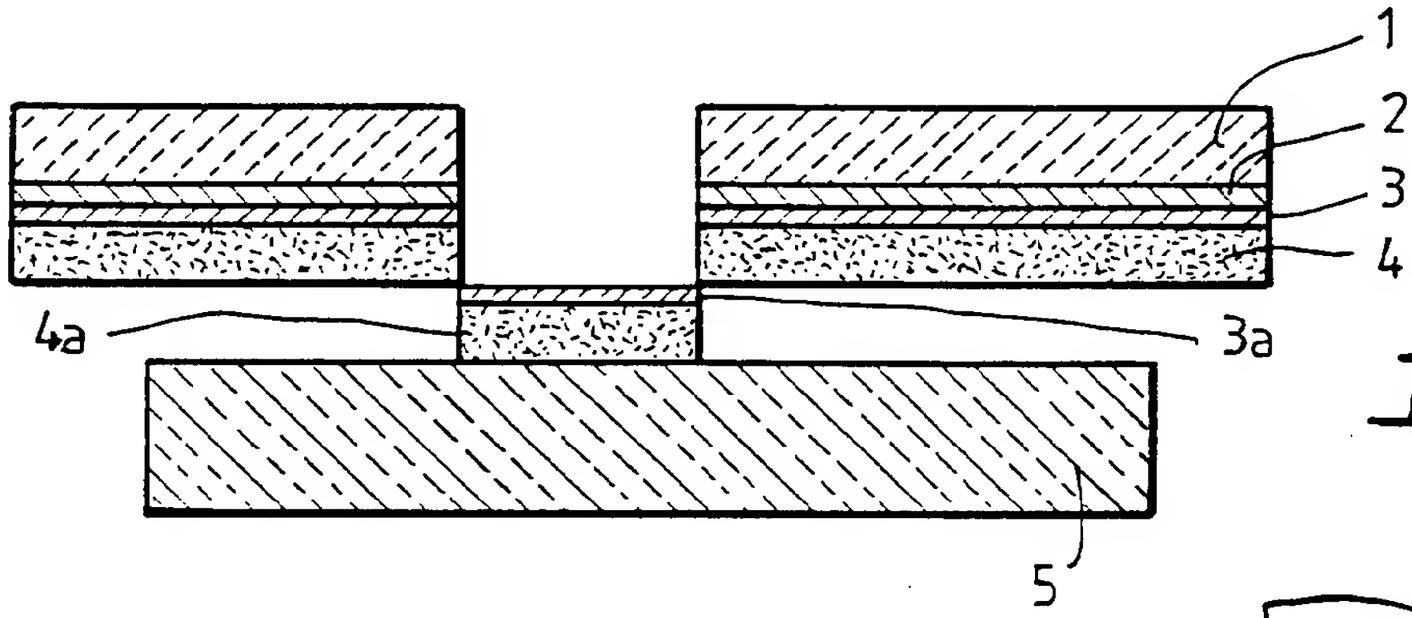

FIG. 2a.

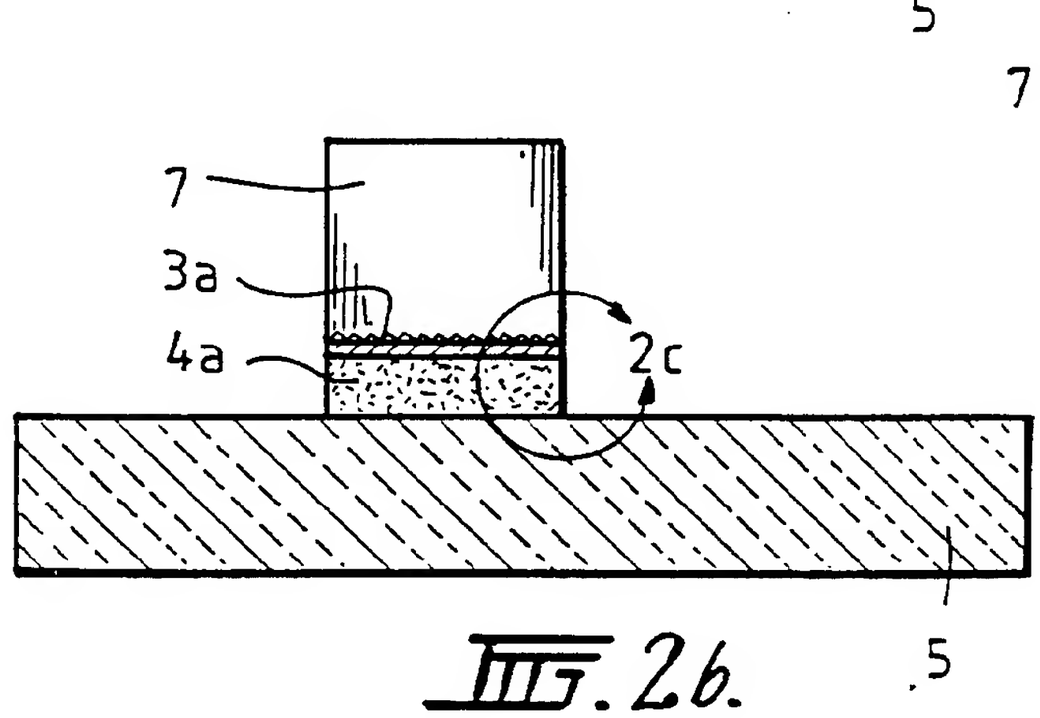

FIG. 2b.

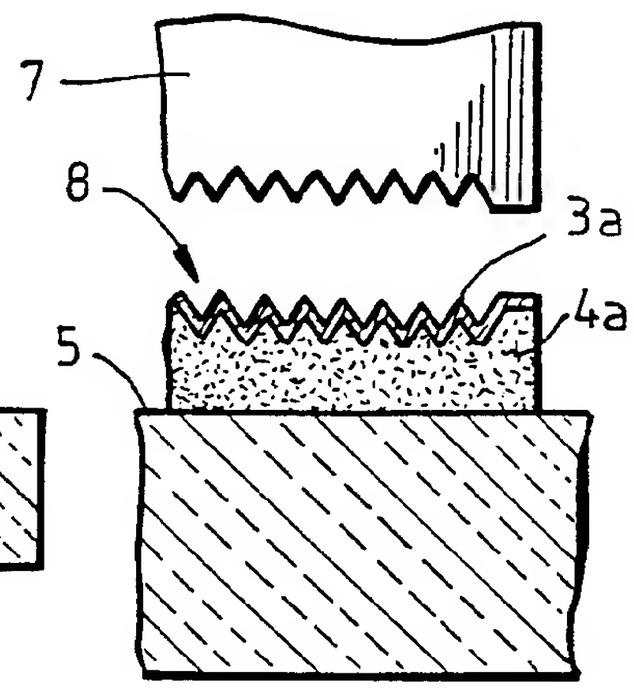

FIG. 2c.

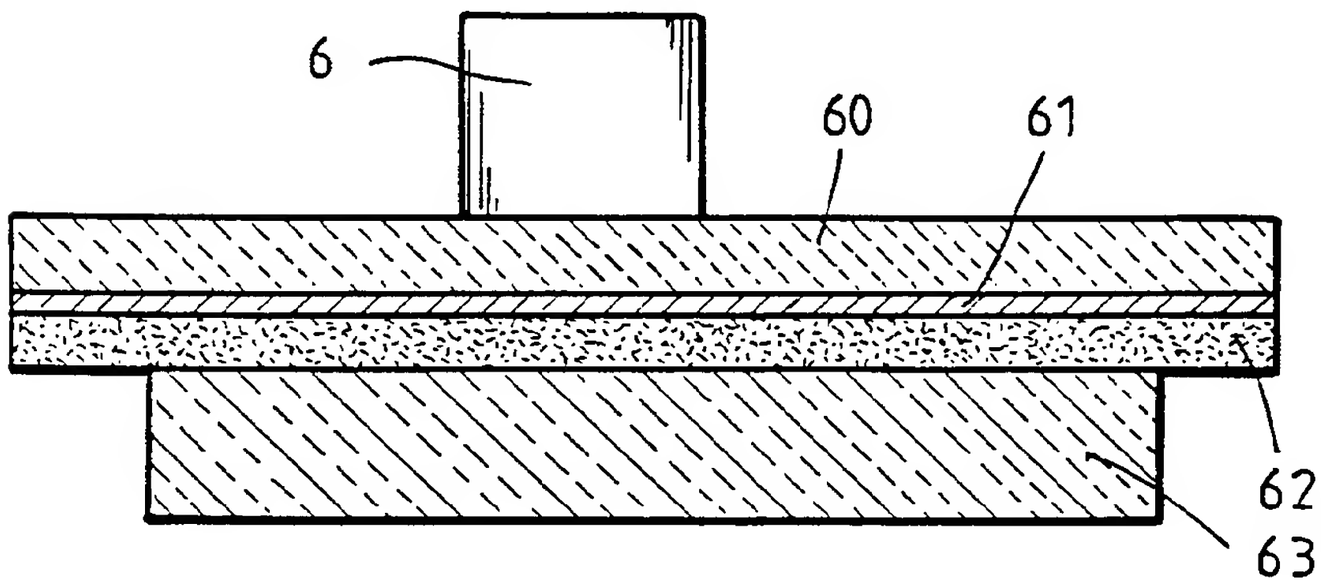

FIG. 12.

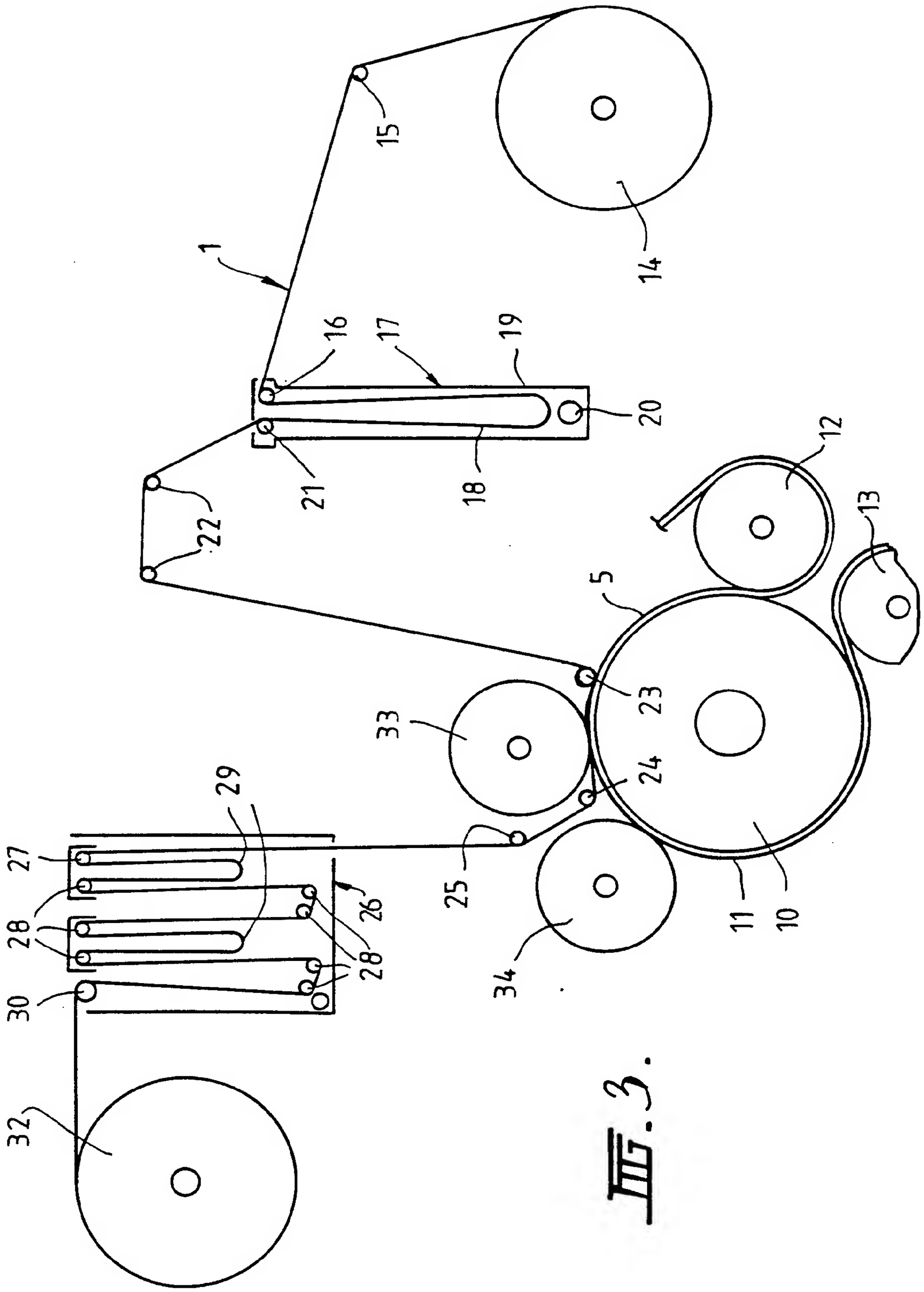
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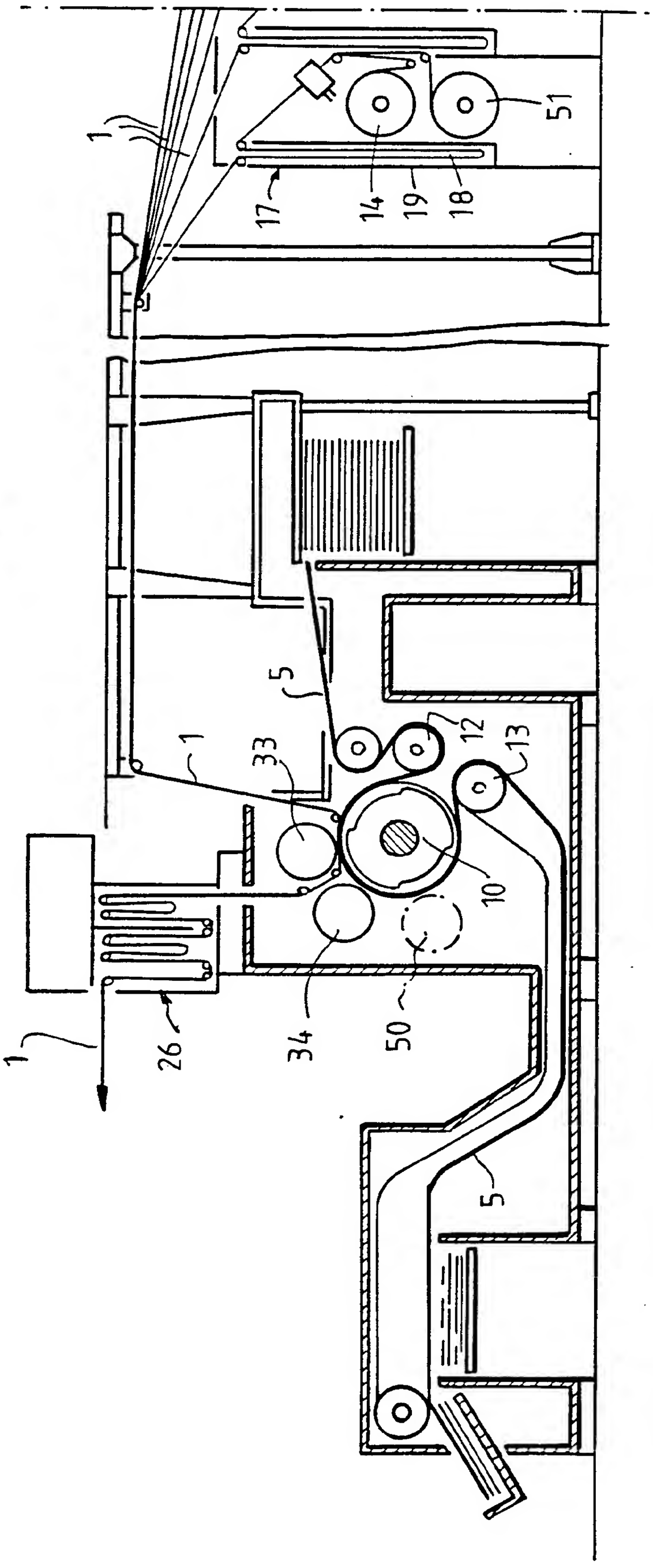
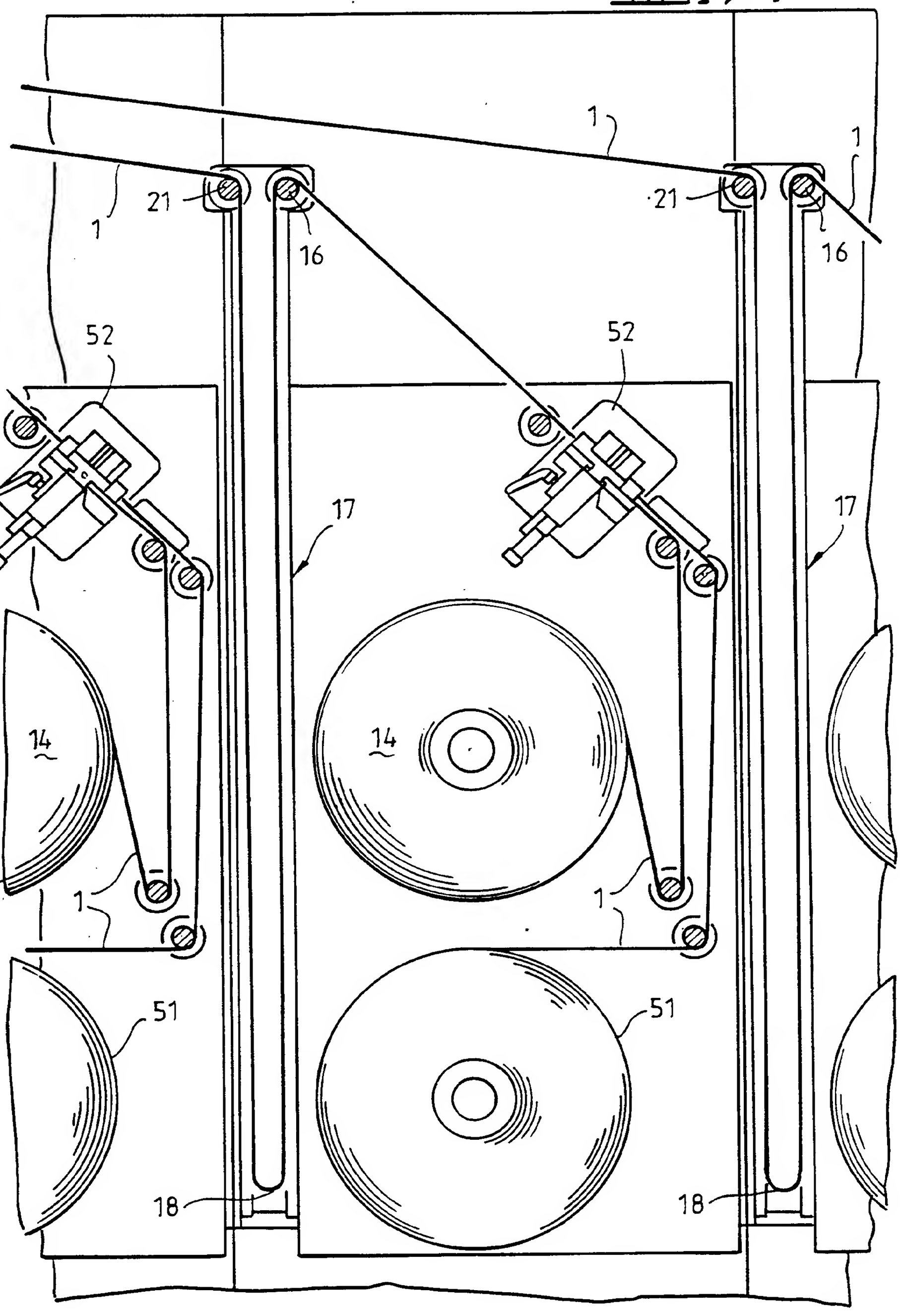
FIG. 3.



Фиг. 4.

FIG. 5.



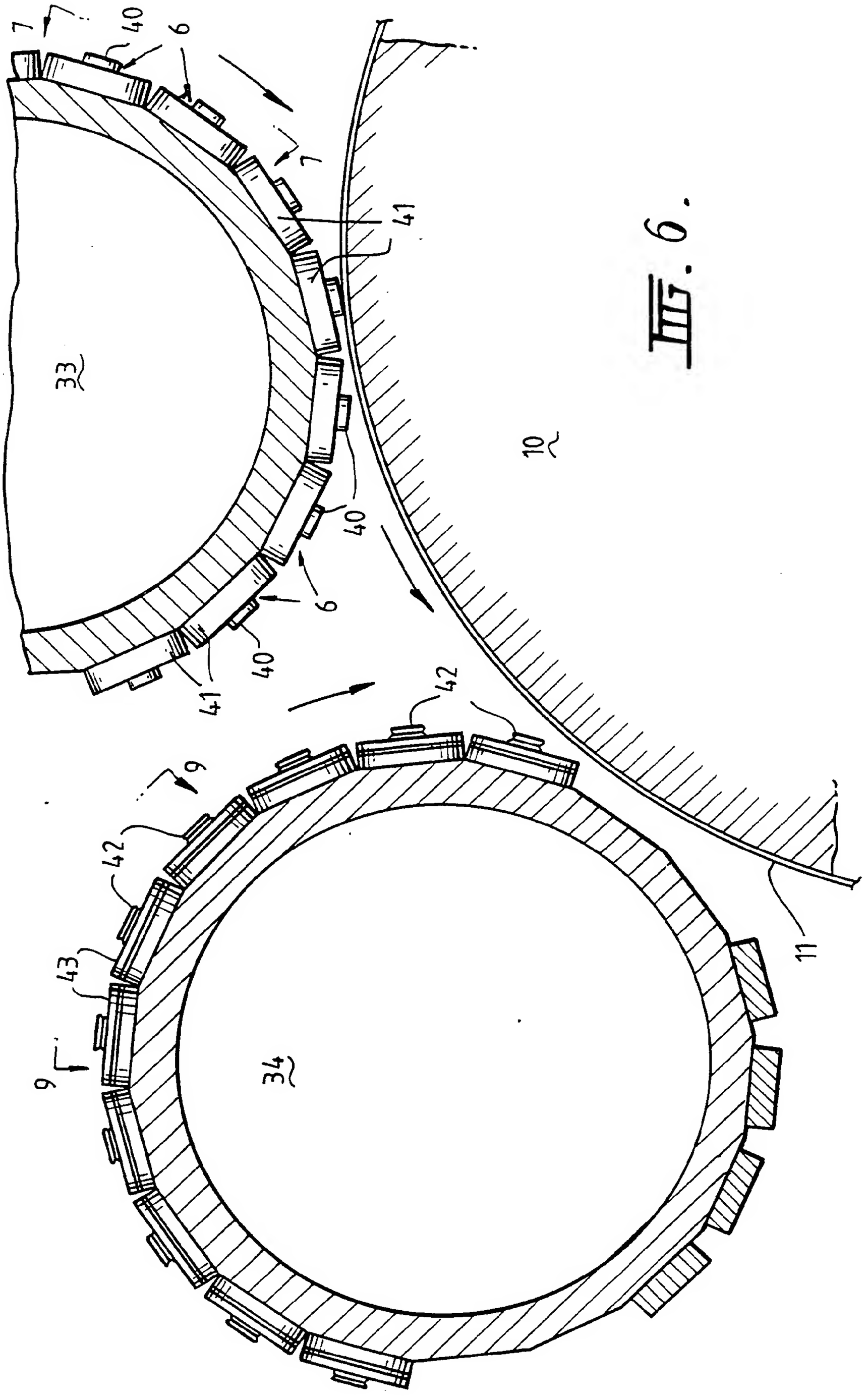


Fig. 6.

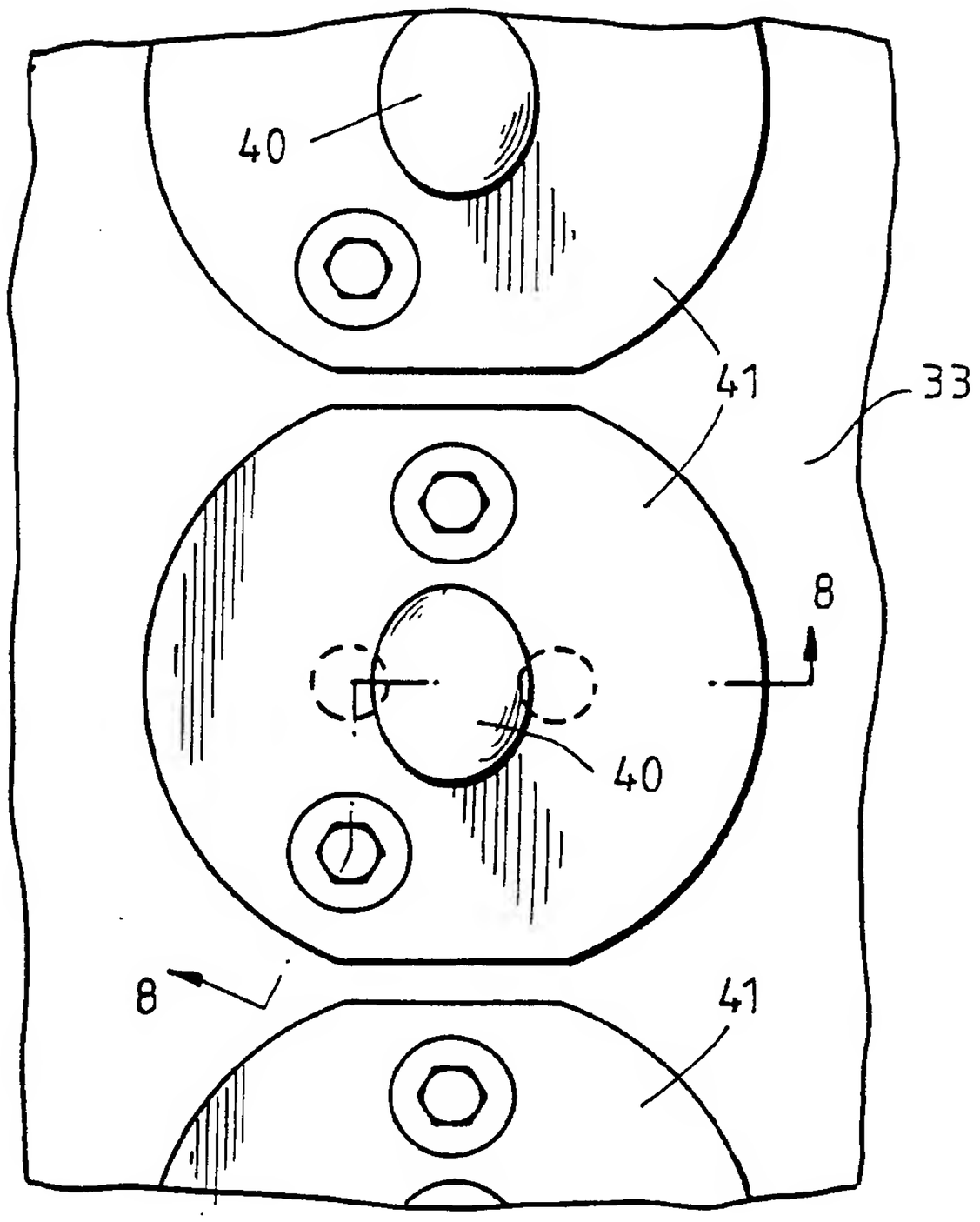


FIG. 7.

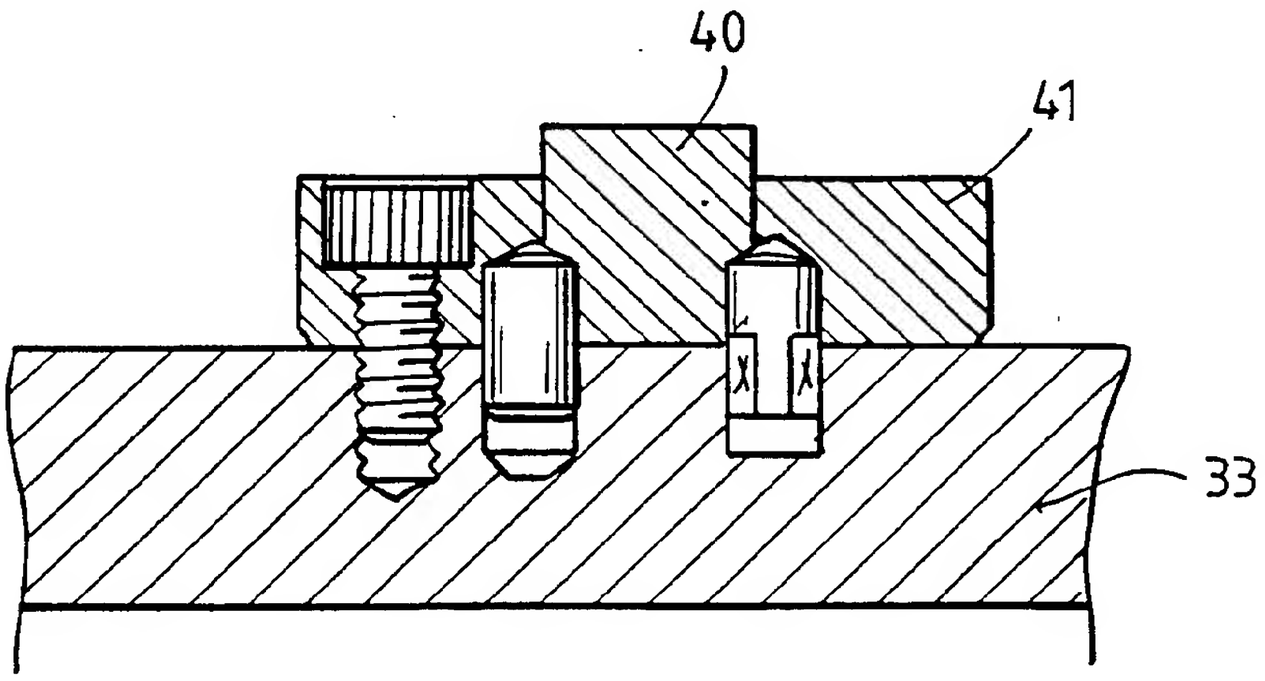


FIG. 8.

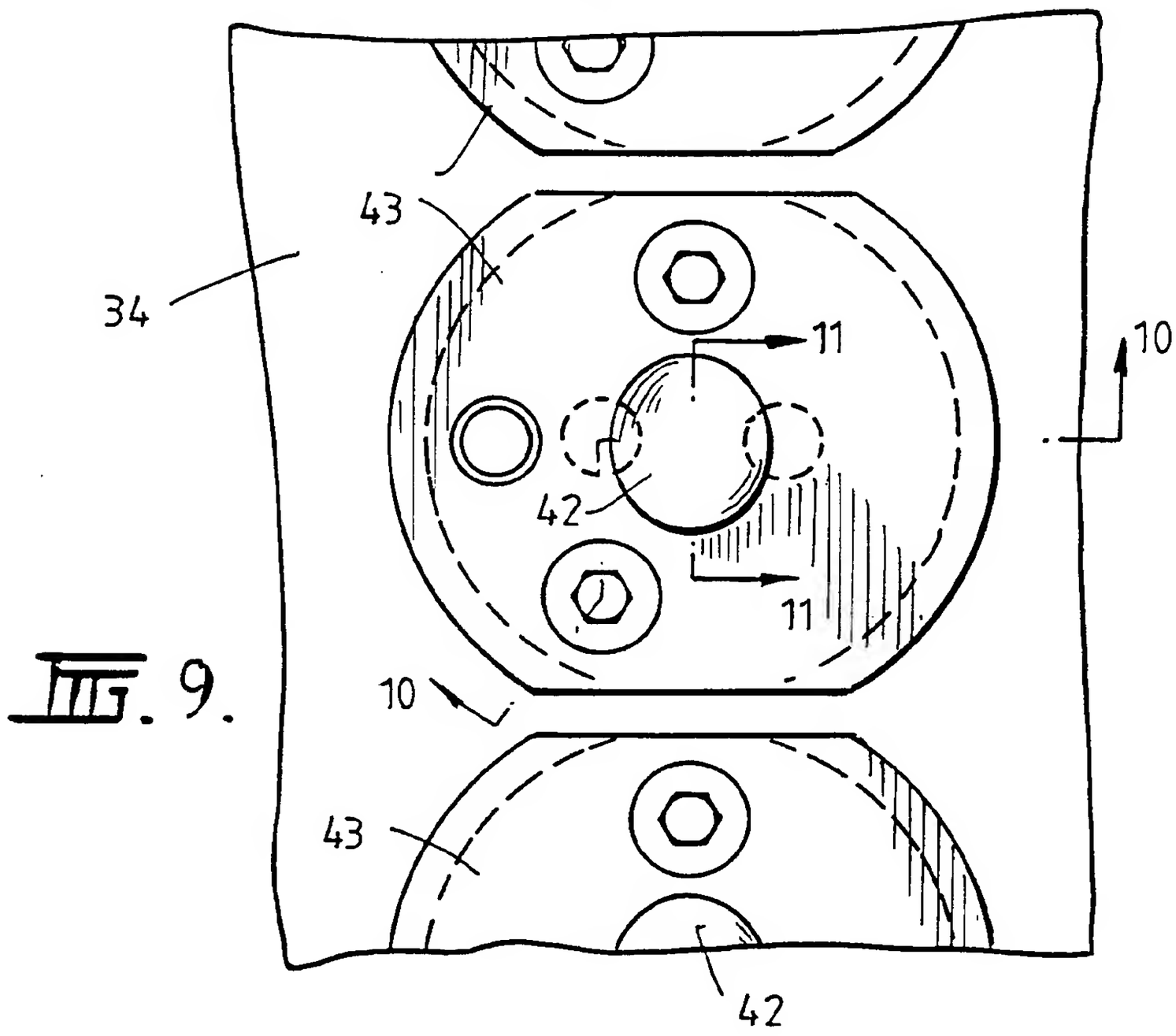


FIG. 9.

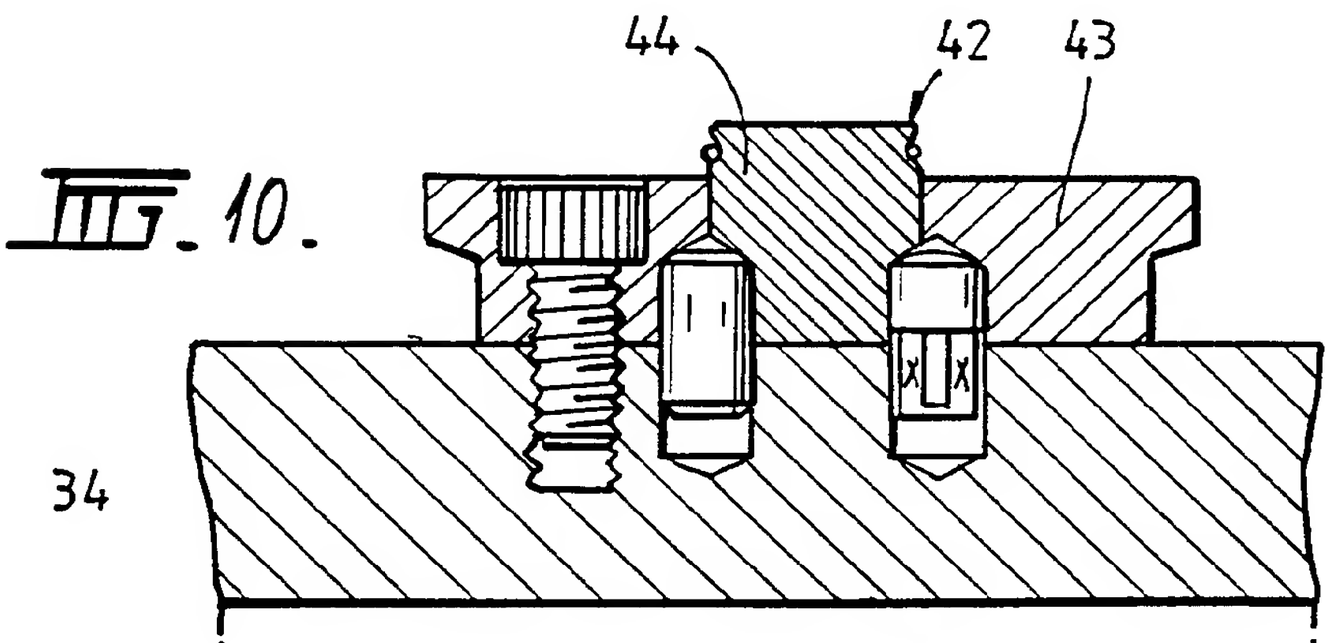


FIG. 10.

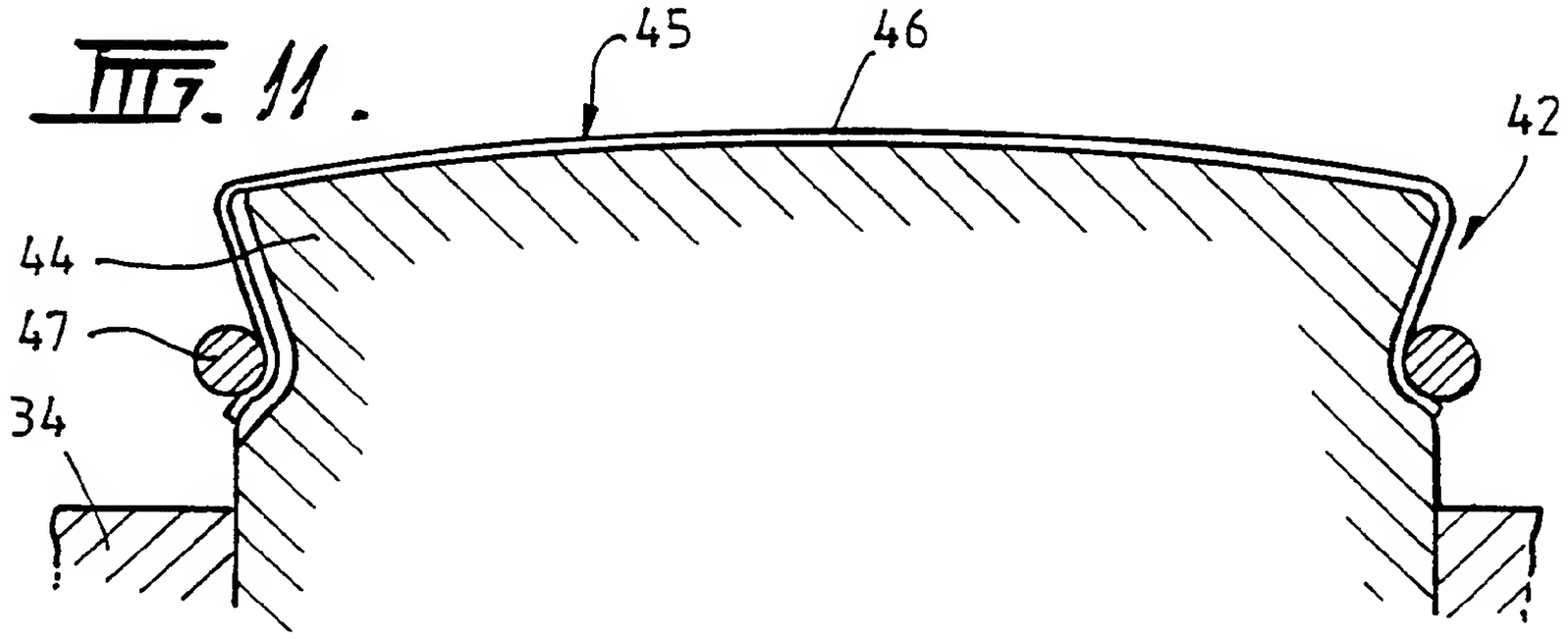


FIG. 11.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 93/00243

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[5] B42D 15/10, 105:00, 209:00, B41F 19/02, B41M 1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC B42D 15/00, 15/10, 105:00, 209:00, B41F 19/02, B41M 1/24, B44F 1/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	AU,A, 84762/91 (GAO GESELLSCHAFT FUR AUTOMATION UND ORGANISATION MBH) 2 April 1992 (02.04.92) page 6 line 28 to page 11 line 14, Figures 3-5.	1-16, 21-32
X	US,A, 4930866 (BERNING et al) 5 June 1990 (05.06.90) column 3 line 5 to column 4 line 33, column 5 line 55 to column 6 line 39, Figures 1 and 4.	1-16, 21-32
X	Patent Abstracts of Japan, M-948, page 91, JP,A, 2-1393 (DAINIPPON PRINTING CO. LTD.) 5 January 1990 (05.01.90)	1-15

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 August 1993 (16.08.93)	23 AUG 1993 (23·08·93)

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AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION
PO BOX 200
WODEN ACT 2606
AUSTRALIA

Facsimile No. 06 2853929

Authorized officer

M. G. Kraefft

M.G. KRAEFFT

Telephone No. (06) 2832218

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	**Citation of document, with indication, where appropriate of the relevant passages**	**Relevant to Claim No.**
X,Y	DE,A, 3308831 (AMERICAN BANK NOTE CO.) 10 May 1984 (10.05.84) page 14 line 37 to page 16 line 35, Figures 5-8.	1-16, 21-32
X,Y	DE,A, 4018057 (LEONHARD KURZ GMBH & CO.) 12 December 1991 (12.12.91) page 3 line 55 to page 4 line 41, Figures 1-3b.	1-16, 21-32
Y	DE,A, 2649479 (LEONHARD KURZ) 3 May 1978 (03.05.78) page 9 line 26 to page 10 line 33, Figures 1 and 2.	1-16, 21-32
A	US,A, 5042842 (GREEN et al.) 27 August 1991 (27.08.91) Figure 2	1-15
A	GB,A, 2211760 (ADVANCED HOLOGRAPHICS LTD) 12 July 1989 (12.07.89) Figure 1, abstract	1-15

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
AU 84762/91	CA 2052232, DE 4030493, EP 477535, JP 4273392, MX 9101146, ZA 9106843
US 4930866	US 4705300, US 4779898
DE 3308831	CA 1257992, CH 656721, FR 2535864, GB 2129739, JP 59088780, US 4728377, US 4913504
DE 2649479	GB 1568563, JP 53056506
DE 4018057	EP 461475, JP 4232088
US 5042842	CA 2045334

END OF ANNEX